

EMPOWERING SUSTAINABLE RESEARCH AND INNOVATION THROUGH EDUCATION: UNCOVERING WELL-BEING, INCLUSION, AND EQUALITY

IMPULSANDO LA INVESTIGACIÓN Y LA INNOVACIÓN SOSTENIBLES A TRAVÉS DE LA EDUCACIÓN: DESCUBRIENDO EL BIENESTAR, LA INCLUSIÓN Y LA IGUALDAD

Gökmen DURMUŞ¹ y Ömer FARUK RENÇBER²

¹*Universidad de Gaziantep, Turquía*

gokmendurmus@gantep.edu.tr

 <https://orcid.org/0000-0001-5809-8459>

²*Universidad de Gaziantep, Turquía*

ofrencber@gantep.edu.tr

 <https://orcid.org/0000-0001-8020-2750>

ABSTRACT: Introduction: This study aimed to examine the impact of the development in the education level of countries on their sustainable research-innovation ecosystem. Further, it aims to reveal how the inclusion, well-being, and equality situations of countries have a mediating effect on education and sustainable research-innovation ecosystems. **Method:** The data used in the study was obtained from the Sustainable Governance Index report and covers the accessible period between 2014 and 2022 (excluding 2021) and 41 countries that are OECD or EU members. Correlation and regression analysis were applied to determine the relationship between the variables in the model. **Results:** The analysis demonstrated that the gender wage gap, poverty rate, and integration variables negatively affected the sustainable research-innovation ecosystem. However, the variables of life satisfaction and social inclusion had a positive impact on the sustainable research-innovation ecosystem. It is found that poverty and integration variables have a negative mediating effect on education but gender wage gap, life satisfaction, and social inclusion variables have a positive mediating effect on education. **Conclusion and Discussions:** The study offers a different perspective for countries that want to raise research-innovation levels. The effects of other variables, such as economic stability, health expenditures, renewable energy, etc., on innovation can be examined.

KEYWORDS: innovation; research; inclusion; gender wage gap; equality; education.

RESUMEN: Introducción: Este estudio tuvo como objetivo examinar el impacto del desarrollo en el nivel educativo de los países en su ecosistema sostenible de investigación e innovación. Además, busca revelar cómo las situaciones de inclusión, bienestar e igualdad en los países tienen un efecto mediador entre la educación y los ecosistemas sostenibles de investigación e innovación. **Método:** Los datos utilizados en el estudio se obtuvieron del informe del Índice de Gobernanza Sostenible y abarcan el período accesible entre 2014 y 2022 (excluyendo 2021) en 41 países miembros de la OCDE o la UE. Se aplicaron análisis de correlación y regresión para determinar la relación entre las variables del modelo. **Resultados:** El análisis demostró que la brecha salarial de género, la tasa de pobreza y las variables de integración afectaron negativamente al ecosistema sostenible de investigación e innovación. Sin embargo, las variables de satisfacción con la vida y la inclusión social tuvieron un impacto positivo. Se encontró que la pobreza y la integración tienen un efecto mediador negativo en la educación, mientras que la brecha salarial de género, la satisfacción con la vida y la inclusión social tienen un efecto mediador positivo. **Conclusión y discusión:** El estudio ofrece una perspectiva diferente para los países que desean elevar sus niveles de investigación e innovación. Se podrían examinar los efectos de otras variables, como la estabilidad económica, el gasto en salud, las energías renovables, etc., sobre la innovación.

PALABRAS CLAVE: innovación; investigación; inclusión; brecha salarial de género; igualdad; educación.

1. INTRODUCTION

Countries that devote abundant resources to research and innovation systems are expected to prosper. Also, firms that invest in R&D activities are inclined to be more resistant and perform well. However, firms prefer advanced countries in innovation, law, and economic stability. For this reason, innovation ecosystems in the country are vital for the company's innovativeness and longevity.

Social inclusion helps build social capital, essential for collaborative research endeavours. A well-educated population with equitable access to resources is more likely to contribute to the economy through innovative products, services, and processes. Countries with strong research and innovation infrastructures are better positioned to compete internationally in a globalized world. In conclusion, the mediator effects of well-being, social inclusion, and equality are essential for creating educational environments that nurture individual potential and contribute to constructing robust research and innovation infrastructures. These factors play a critical role in developing human capital, fostering a healthy society, and driving economic progress.

In this study, we started from the point of researchers' and firms' innovation sum in a country. It is an intriguing issue that while some countries are leading in creativity, such as patents, know-how, innovation, and inventions, some are lagging behind others. So why some countries are more innovative than others? What makes them more innovative than other countries? Why do some firms are more innovative in one country rather than another? We

called this concept the «research and innovation ecosystems» of the countries in this study. In this innovation cycle, what is the role of education? How do inclusion, well-being, and equality play a role in innovation? How do they affect the result? To get answers to these questions we used the indicators of the Sustainable Governance Index. The index obtained data from 41 OECD or EU member countries. The study aimed to examine the impact of the development in the education level of countries on their sustainable research-innovation ecosystem. Further, it aims to reveal how the inclusion, well-being, and equality situations of countries have a mediating effect on education and sustainable research-innovation ecosystems. The study offers different perspectives for countries that want to raise research-innovation levels. It also shows the importance in terms of examining the impact of variables such as economic stability, health expenditures, renewable energy, etc., on innovation.

1.1. RESEARCH AND INNOVATION ECOSYSTEMS

The first and most significant definition of innovation was put forth by Schumpeter in 1934. He described innovation as a novel combination of productive resources and linked it to economic development (Schumpeter, 1934). In developed economies, successful organizations transform their learning capabilities into innovation. This organizational skill returns as a competitive advantage and possibly profit for companies. This happened through knowledge management. Knowledge management is considered a key driver of growth and competitive advantage of organizations (Moustaghfir & Schiuma, 2013). Innovation can be categorized into three groups: outcome, process, and mindset (see Table 1).

Table 1. Understanding Innovation (Kahn, 2018)

Element	Strategic focus	Strategic question	Consideration
Innovation is an outcome	Ends	What do you want to happen?	- Production innovation - Process innovation - Marketing innovation - Business model innovation - Supply chain innovation - Organizational innovation
Innovation is a process	Ways and Means	How will you make it happen?	- Innovation process - Product development process
Innovation is a mindset	State	What should be instilled and ingrained to prepare for the what and the how?	- Individual mindset - Organization culture

Innovation can be seen as the outcome of various factors such as product, process, marketing, business model, supply chain, and organizational innovation. The process of innovation involves structuring innovation to produce results, including developing new products and overall innovation processes. «Innovation as a mindset» refers to the internalization of creativity by individual members and the development of an encouraging organizational culture that fosters innovation (Kahn, 2018).

1.2. EDUCATION AND INNOVATION

One measure of a firm's innovative potential is its adaptive capacity, or ability to use outside knowledge. For this reason, a firm's investment in R&D contributes to its adaptive capacity (Cohen & Levinthal, 1990). In a study conducted on Norway, Kuhlmann and Arnold (2001) found that even though Norway is rich in resources of raw materials, especially in oil and gas; the innovation rate of small and large companies was found low compared to Sweden and Finland. The researchers suggested that the adaptive capacity of the companies could be increased if the university system produces a sufficient number of scientists and technology professionals with degrees in special doctorate-level. Therefore, the upward mobility of scientists and academics with doctoral degrees is important for speeding up innovation cycles.

1.3. INCLUSION AND INNOVATION

Inclusion is regarded as one of the prominent conceptual dimensions of responsible research and innovation (Burget *et al.*, 2017). Engaging the public can help achieve socially desired results. Because it is believed to have a favorable impact on technological development. Barben *et al.* (2008) have emphasized the significance of involving the public in the initial research and development phases. However, some regulatory bodies such as the European Union, the National Nanotechnology Initiative, and the National Research Council put stress on responsible research and innovation concepts by advising science organizations to stay in responsible research and innovation areas. In a responsible research model, inclusiveness is crucial. The involvement of all actors –researchers, civil society organizations, industry, and policy-makers– at the very beginning stage allows them to contribute to innovation processes with a co-building mode, fostering co-responsibility like in the Danish model (Owen *et al.*, 2012).

1.4. WELL-BEING, EQUALITY AND INNOVATION

Well-being is vital in innovation ecosystem because it is both outcome and component of innovation at the individual (Rickard *et al.*, 2016; Wang & Xue, 2017), organizational (Keegan, 2015; Bryson *et al.*, 2009; Robert *et al.*, 2017), and national level (Engelbrecht, 2015, 2018). A study conducted in Sweden found that organizational climate is correlated

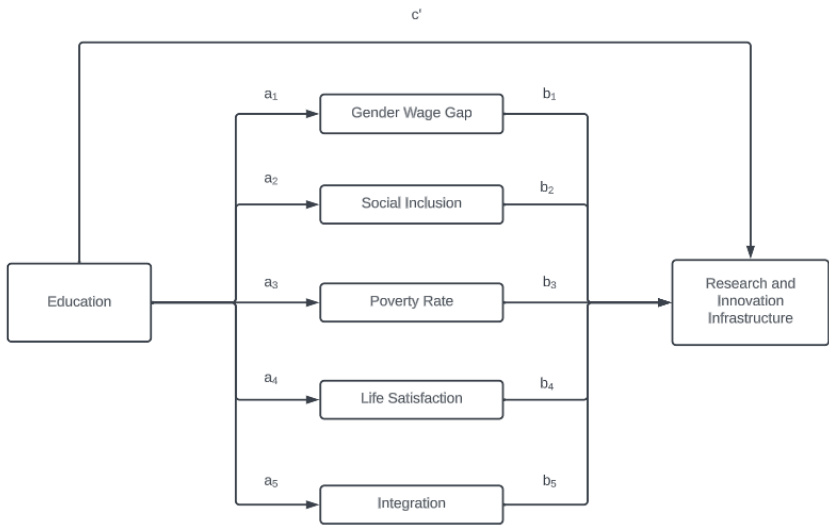
with innovation, creativity, and well-being in organizational settings. Also, improving innovation reflected positively on employees' psychological well-being (Rasulzada & Dackert, 2009). The well-being of employees in organizations has been studied by several researchers. An acceptable level of stress may lead to increased creativity, but high levels of stress can be disruptive to the psychological well-being of employees and creativity levels (Amabile *et al.*, 2002; Amabile *et al.*, 2005). Team climate is important in well-being and creativity issues. An improved team climate that fosters creativity may improve employee well-being and reduce stress-related reactivity in organizations (Dackert, 2010). Leadership is significantly related to organisational innovation (Oldham & Cummings, 1996; Scott & Bruce, 1994). Especially transformative leadership promotes creativity in organizations (Bass & Avolio, 1994). Under efficient leadership, organizations can be more innovative and productive. However, firms' demand for innovativeness sometimes may lead to burnout of employees. It is necessary to manage innovation as a source of resources and demands that later affect engagement and burnout (Huhtala & Parzefall, 2007). Another issue is that public sector funding cuts lead to social exclusion and inequality, which results in the deterioration of the well-being of individuals (Marmot, 2010). Inequality and unemployment are believed to affect the well-being of the population. Researchers found that innovation might sometimes widen inequalities but increase living standards in a society. It is suggested for policy-makers to balance the trade-off between innovation and inequalities for collective well-being (Aldieri *et al.*, 2021).

As a mediator in this study, well-being is often considered regarding mental and physical health outcomes. When students perceive high levels of social integration within their educational environment, their self-esteem may increase, promoting mental and physical well-being. This well-being could potentially enhance their engagement with educational content, fostering a more innovative mindset and contributing to research infrastructure development. Understanding the mechanisms of inclusion and exclusion at various institutional levels can provide insights into how to create a more equitable education system. In summary, a supportive, inclusive, and equitable educational environment can enhance individual well-being, leading to greater engagement with research activities and supporting the development of robust research and innovation infrastructure.

2. METHODOLOGY

The data used in the study was obtained from the Sustainable Governance Index report and covers the accessible period between 2014 and 2022 (excluding 2021) and 41 countries that are OECD or EU members. To draw conclusion, we performed correlation analysis and regression analysis to the set of data extracted from the Sustainable Governance Index report. Correlation analysis was applied to determine the relationship between the variables in the model. Also, skewness and kurtosis coefficients were examined to understand whether the variables were normally distributed.

Figure 1. Research Model



With the help of regression analysis, the parallel mediating effect of variables inclusion, well-being, and equality- on countries' education and sustainable research-innovation ecosystem was examined. For this purpose, firstly, the direct effect between independent-mediator and mediator-dependent variables was examined. Then, calculations were made on the mediating roles of the intermediary variables in the model.

2.1. PURPOSE AND SCOPE

This study examines the mediating effect of equality, inclusion, and well-being on the relationship between education and sustainable research and innovation infrastructure. Specifically, we predict that improvements in a country's education system will improve its sustainable research and innovation infrastructure. However, this study aims to investigate the impact of inclusion, well-being, and equality on education and sustainable research and innovation infrastructure.

The data used in the study were obtained from the Sustainable Governance Index report, covering the period between 2014 and 2022 (excluding 2021) for 41 countries listed in the table below. The data used in the study were obtained from the Sustainable Governance Index report, covering the period between 2014 and 2022 (excluding 2021) for 41 countries listed in the table below.

Table 2. Countries Listed on SGI Report- 2023

Australia	Finland	Latvia	Romania
Austria	France	Lithuania	Slovakia
Belgium	Germany	Luxembourg	Slovenia
Bulgaria	Greece	Malta	South Korea
Canada	Hungary	Mexico	Spain
Chile	Iceland	Netherlands	Sweden
Croatia	Ireland	New Zealand	Switzerland
Cyprus	Israel	Norway	Turkey
Czechia	Italy	Poland	United Kingdom
Denmark	Japan	Portugal	United States
Estonia			

3. RESULTS

Correlation analysis was applied to determine the relationship between the variables. In addition, skewness and kurtosis coefficients were analysed to determine whether the variables were normally distributed. The fact that these values are between +1.5 and -1.5 is sufficient for assuming that the data are normally distributed. Other findings obtained are in the table below.

Table 3. Descriptive statistics and correlation analysis results for the variables

Variables	Skewness (Kurtosis)	VIF	Mean±SD	RIN	ED	SI	Poverty	LS	GWG
Research Ecosystem	0.19 (-1.13)	-	5.41±1.83						
Education	-0.34 (-0.59)	3.35	6.1±1.09	.691**	—				
Social Inclusion	0.83 (-1,1)	7.25	5.9±1.23	.523**	.565**	—			
Poverty Rate	-0.11 (-1.2)	3.26	5.45±1.64	.244**	.241**	.781**	—		
Life Satisfaction	-0.37 (-0.69)	2.26	5.47±1.28	.648**	.546**	.706**	.460**	—	
Gender Wage Gap	-0.84 (1.23)	1.78	6.86±1.69	-.392**	-.367**	.205**	.203**	-0.046	—
Integration	-0.48 (0.73)	1.53	6.55±1.13	.327**	.580**	.332**	.118*	.373**	-.173**

As shown in Table 3, the skewness and kurtosis coefficients of the variables are within the lower and upper limits. Therefore, it is considered that the variables are normally distributed. According to the correlation analysis results, it is seen that the variables with the highest level of relationship are between social inclusion and poverty (0.781) and life satisfaction (0.706). This situation can be considered to cause multicollinearity problem. However, according to the VIF values ($VIF < 10$), it was concluded that the necessary conditions for classical regression analysis were met. In measuring macroeconomic problems, explaining the dependent variable with only one factor may be quite weak. For this reason, in order for the results of the researched issue to be inclusive, it should be analysed from a broader perspective. For this reason, the parallel mediation effect of inclusion, well-being and equality variables on the relationship between education and sustainable research and innovation infrastructure of countries is analysed. For this purpose, the direct effect between the variables as independent-mediator and mediator-dependent is analysed. Then, calculations were made on the mediating roles of the mediating variables in the model.

Parallel Multiple Mediation Analysis showed that all variables explained 66 % of the variance and the model was significant ($F(6,321) = 104.47, p < 0.01$). To test the significance of the mediation effect, indirect effect analysis –which was suggested by Hayes– was applied. Accordingly, all paths between the mediator variables and the dependent variable were found to be significant, and it was revealed that the variables with the highest level of relationship were between social inclusion and poverty (0.781) and life satisfaction (0.706). The analysis demonstrated that the gender wage gap, poverty rate, and integration variables negatively affected the sustainable research-innovation ecosystem. However, the variables of life satisfaction and social inclusion positively impacted the sustainable research-innovation ecosystem. It is found that poverty and integration variables have a negative mediating effect on education but gender wage gap, life satisfaction, and social inclusion variables have a positive mediating effect on education.

Table 4. Analysis results for the variables

M1				M2			M3			M4			M5			Y	
Gender wage gap				Social Inclusion			Poverty Rate			Life Satisfaction			Integration			Research Ecosystem	
		Coeff.	S.E.			Coeff.	S.E.			Coeff.	S.E.			Coeff.	S.E.		
X (Education)	a ₁	-0.57*	0.08	a ₂	0.64*	0.05	a ₃	0.36*	0.08	a ₄	0.64*	0.05	a ₅	0.60*	0.05	c'	0.48*
M1 (Gender wage gap)	-			-			-			-			-			b ₁	-0.36*
M2 (Social Inclusion)	-			-			-			-			-			b ₂	0.58*
M3 (Poverty Rate)	-			-			-			-			-			b ₃	-0.23*

	M1		M2		M3		M4		M5		Y
	Gender wage gap		Social Inclusion		Poverty Rate		Life Satisfaction		Integration		Research Ecosystem
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	
M4 (Life Satisfaction)	-		-		-		-		-		b ₄ 0.50*
M5 (Integration)	-		-		-		-		-		b ₅ -0.21*
Constant	10.36	0.5	2.01	0.32	3.23	0.5	1.55	0.3	2.86	0.3	
R ²	0.135		0.32		0.058		0.298		0.336		0.66
MSE	2.48		1.03		2.54		1.15		0.85		1.16
F	50.67*		153.1*		20.08*		138.5*		165.2*		104.47*

As seen in Table 3 and Table 4, while the variables of poverty and integration have a negative mediating effect, the gender wage gap, life satisfaction, and social inclusion have a positive mediating effect. This situation can be summarized in bullet points as follows:

- When other mediating variables are controlled, sustainable education development reduces wage inequality, enhancing the research ecosystem. Therefore, although the factor of wage inequality diminishes its influence on improving education quality, it still has a positive effect on the outcome.
- When other mediating variables are controlled, as the quality of education increases, so does the social inclusiveness of countries. This can also lead to an increase in the research ecosystem.

When other mediating variables are controlled:

- Contrary to expectations, an increase in education quality is seen to cause an increase in poverty. The rise in poverty can lead to a decrease in the research ecosystem.
- As education quality improves, people's life satisfaction increases. This has a positive effect on the research ecosystem.
- Although an increase in education quality causes an increase in integration, it leads to a decrease in the research ecosystem.

When all mediating variables are considered together and other mediating variables are controlled, it has been concluded that poverty is the variable with the most significant mediating effect in the relationship between the research ecosystem and education, yet this effect is negative. Following this, social inclusion, life satisfaction, and gender-based wage inequality have been observed to have positive mediating effects. The least significant mediating variable has been concluded to be integration, which has a negative effect. We have concluded from this study that; innovation has strong bonds with life of satisfaction and social inclusion. A country that aims to raise innovation levels should pay more attention to increasing life of satisfaction and social inclusion and decreasing the gender wage gap and poverty rate. The

surprising finding in this study was the integration and innovation relationship. There is no doubt that further research should be conducted on integration and innovation issues.

4. CONCLUSION

This study offers a different perspective for countries that want to raise research-innovation levels. Policies could be implemented to reduce gender wage gaps, as this has a positive mediating effect on improving education quality and the research ecosystem. Policies could include pay transparency laws, minimum wage increases, and family leave policies. Policy-makers can increase funding for social inclusion initiatives in education, as increased inclusion mediates positive effects on education quality and research; fund specialized training for educators, assistive technologies, and programs for fostering inclusive environments. Based on our findings, we suggest the following actions to increase the level and quality of innovation. Countries can address rising poverty rates that could diminish returns on educational investments, and expand social safety net programs, job training initiatives, affordable housing, and access to healthcare; foster inclusive environments celebrating diverse backgrounds and learning needs; provide sensitivity/implicit bias training for staff, mentorship programs, and targeted student support services; monitor student life satisfaction via surveys. Implement advising, mental health services, and environments promoting wellbeing. Satisfaction increases mediate positive effects; evaluate integration initiatives helping marginalized student groups. Despite increasing education quality, declining integration mediates negative research ecosystem effects. Further, governments can examine interventions for addressing mediating poverty rates, as poverty most significantly diminishes positive returns on educational advances. They can study programs lifting households out of poverty; and research social inclusion best practices enhancing outcomes for marginalized groups by assessing the strengths and weaknesses of existing inclusion models. Also, they can investigate life satisfaction factors influencing student outcomes by identifying services and environmental factors that boost satisfaction and achievement. It is suggested to explore integration barriers for certain student demographics face despite overall education quality improvements and to identify approaches to overcoming challenges.

Future researchers can examine different sides of innovation. They can approach the innovation issue from other variables, such as; economic stability, health expenditures, renewable energy, rule of law, civil rights etc. These studies can contribute to our knowledge of innovation.

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